MULTIRADIATION GENERATION APPARATUS AND RADIATION IMAGING SYSTEM UTILIZING DUAL-PURPOSE RADIATION SOURCES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multiradiation generation apparatus, which is applicable to, for example, nondestructive X-ray imaging used in the fields of medical equipment and industrial equipment, and to a radiation imaging system using the multiradiation generation apparatus.

2. Description of the Related Art

In recent years, in the field of radiation imaging such as mammography, tomosynthesis imaging has been performed as a technique for obtaining information on the depth direction of an object. In tomosynthesis imaging, an object is irradiated with radiation from a plurality of angles to capture a plurality of images. The obtained images are reconstructed to obtain a cross-sectional image.

Normally, in tomosynthesis imaging, an operator performs imaging by irradiating an object with radiation while moving radiation tubes at an angle within a predetermined angle range (approximately ±7.5° to ±25°) with respect to the object.

U.S. Pat. No. 8,094,773 discusses a three-dimensional X-ray image generation device. By using a plurality of X-ray sources and sequentially irradiating an object with the X rays from a plurality of angles, this device performs tomosynthesis imaging while maintaining the X-ray sources in a fixed state. In addition, there is discussed a device including non-tomosynthesis imaging X-ray sources outside a tomosynthesis imaging path, in addition to tomosynthesis imaging X-ray sources.

The apparatus that involves the movement of the radiation tubes during imaging has problems. For example, artifacts are formed on images. In addition, since time is required for the mechanical movement, imaging time is prolonged. In addition, movement of the radiation tubes could give a subject a sense of fear.

In clinical practice, there are cases in which both tomosynthesis images and conventional two-dimensional (2D) images (non-tomosynthesis images) are used. These 2D images are advantageous since the 2D images can provide higher spatial resolution than that of tomosynthesis images and medical professionals can make use of years of knowledge. Thus, it is effective to use tomosynthesis images for specifically observing a portion that seems suspicious on 2D images.

However, if tomosynthesis imaging radiation sources and non-tomosynthesis imaging radiation sources are separately provided, the configurations of the apparatuses are made complex, thereby increasing manufacturing costs of the apparatuses. In addition, the tomosynthesis images and non-tomosynthesis images need to be appropriately associated with each other. Thus, the positional relationship among the tomosynthesis imaging radiation sources and the non-tomosynthesis imaging radiation sources needs to be optimized, which is a layout constraint.

SUMMARY OF THE INVENTION

The present invention is directed to a multiradiation generation apparatus applicable to both tomosynthesis imaging and non-tomosynthesis imaging with a simpler configuration and a radiation imaging system using the multiradiation generation apparatus.

According to an aspect of the present invention, a multiradiation generation apparatus includes a plurality of radiation sources arranged in a row. Each of the radiation sources includes an electron source configured to emit electrons and a target unit configured to generate radiation upon receiving electrons emitted from the electron source. At least one of the radiation sources is a dual-purpose radiation source used for both tomosynthesis imaging and non-tomosynthesis imaging, and the other radiation sources are single-purpose radiation sources used only for tomosynthesis imaging.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A, **1**B, and **1**C illustrate a multiradiation generation apparatus according to a first exemplary embodiment. More specifically, FIG. **1**A is a front vertical sectional view, FIG. **1**B is a bottom view, and FIG. **1**C is an enlarged sectional view near a dual-purpose radiation source.

FIGS. **2**A, **2**B, and **2**C illustrate a multiradiation generation apparatus according to a second exemplary embodiment. More specifically, FIG. **2**A is a front vertical sectional view, FIG. **2**B is a bottom view, and FIG. **2**C is an enlarged sectional view near a dual-purpose radiation source.

FIG. **3** is a schematic sectional view of a target unit of a dual-purpose radiation source according to a third exemplary embodiment.

FIGS. **4**A and **4**B illustrate a multiradiation generation apparatus according to a fourth exemplary embodiment. More specifically, FIG. **4**A is a front vertical sectional view and FIG. **4**B is a bottom view.

FIGS. **5**A and **5**B illustrate a multiradiation generation apparatus according to a fifth exemplary embodiment. More specifically, FIG. **5**A is a front vertical sectional view and FIG. **5**B is a bottom view.

FIGS. **6**A and **6**B illustrate configurations around a target unit of a dual-purpose radiation source according to a sixth exemplary embodiment. More specifically, FIGS. **6**A and **6**B are schematic sectional views illustrating configurations of shields.

FIG. **7** is a schematic sectional view illustrating an installation configuration of a target unit according to a seventh exemplary embodiment.

FIG. **8** illustrates a configuration of a radiation imaging system according to an eighth exemplary embodiment.

FIGS. **9**A and **9**B illustrate imaging methods using the radiation imaging system according to the eighth exemplary embodiment of the present invention. More specifically, FIG. **9**A illustrates a tomosynthesis imaging method and FIG. **9**B illustrates a non-tomosynthesis imaging method.

DESCRIPTION OF THE EMBODIMENTS

Various exemplary embodiments, features, and aspects of the invention will be described in detail below with reference to the drawings. While X-rays can be used as radiation in exemplary embodiments, other kinds of radiation such as neutron rays or proton beams are also applicable. In addition, hereinafter, a multiradiation generation apparatus **1** will simply be referred to as a radiation generation apparatus **1** and a multi-electron source **4** will simply be referred to as an electron source **4**.

As illustrated in FIGS. **1**A, **1**B, and **1**C, a radiation generation apparatus **1** according to a first exemplary embodiment includes a plurality of radiation sources **2**, each of which has